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ABSTRACT

Four studies investigated children's explanations for family resemblance and species-typical characteristics, under different conditions of biological parentage and rearing environment. Participating were 226 children between 3 and 11 years. Children Children were presented with a number of different tasks, some involving people and some domestic animals. Each task involved interviews in which children predicted what kinds of physical and behavioral characteristics offspring would be most likely to demonstrate under normal biological parentage and rearing, adoptive rearing, inter-uterine transplant parentage and rearing with own species, or inter-uterine transplant parentage and rearing with transplant species. In all studies, particularly those involving non-human animals, there was a strong tendency for children of all ages to draw on essentialist explanations for their predictions. Among the youngest children (3-4 year olds), psychological intentional explanations were common. It was not until 6 to 7 years that explanations clearly began to refer to physical processes and putative biological mechanisms. The period between 4 and 6 years appeared to be a transitional phase where performance and explanations were more variable and seemed to be highly task-dependent. Biological-based, although often inaccurate, explanations for inheritance increased dramatically around 10 to 11 years. (Contains 11 references.) (KDFB)

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Children's Explanations of Family Resemblances

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Poster presented at the Biennial meeting of the Society for Research in Child Development, April 3-6, 1997, Washington, DC.

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ABSTRACT

In a series of four studies, involving 226 children between the ages of 3-11 years, the patterns and frequencies of explanations provided for family resemblances and species-typical characteristics, under different conditions of biological parentage and rearing environment, were examined. In all studies, particularly those involving non-human animals, there was a strong tendency for children at all ages to draw on essentialist explanations for their predictions. Among the youngest children studied (3-4 year olds) psychological intentional explanations were common. It was not until around 6-7 years of age (1st - 2nd grade) that explanations clearly began to refer to physical processes and putative biological mechanisms. Between 4-6 years of age appeared to be a transitional phase where performance and explanations were more variable and seemed to be highly task-dependent. Biologically-based (although often inaccurate) explanations for inheritance increased dramatically around 10-11 years of age (5th grade).

Children's Explanations of Family Resemblances

In recent years a number of researchers have argued that children, as early as 4 years of age, may understand the cross-generational transmission of family resemblances and species-typical characteristics as part of a biological, rather than psycho-social, process (e.g., Gelman & Wellman, 1991; Springer, 1992, 1995, 1996; Springer & Keil, 1989; 1991; Wellman and Gelman, 1992). Others dispute this claim (e.g., Carey 1985; Solomon, Johnson, Zaitchik & Carey 1993, 1996) and argue that not until 7 years of age do children begin to understand inheritance in specifically biological terms. These authors have argued that, to be convincing, it must be demonstrated that young children understand it is the specifically biological act of parentage that underpins inherited characteristics, and distinguish this from possible beliefs they might have about psycho-social influences on family resemblances. As Springer (1996) has recently demonstrated, the different methodologies employed to look at children's understanding of family resemblances may explain some of the age discrepancies appearing between studies. However, few of the studies have explored in any depth the ways in which children themselves explain the phenomena in question. Granted there is a limited amount that very young children can articulate about complex concepts -- but what they can tell us may provide important insights about their understanding, as demonstrated in an elegant study by Bernstein and Cowan (1975) who examined children's concepts of reproduction using a careful content analysis of their spontaneous explanations.

Over the past two years we have conducted several studies exploring children's understanding of family resemblances and the extent to which they appreciate the specifically biological process underpinning the cross-generational transmission of physical characteristics. An overview of this research will be reported here with a specific emphasis on just one aspect of the documented observations, namely how children themselves explain the phenomena in question. Of particular interest with respect to this work have been the studies of Gelman and others on the early and pervasive influence of psychological essentialism on thinking about categories and

causality (e.g., Gelman, 1992; Gelman & Kremer, 1991; Gelman & Medin, 1993; Gelman & Wellman, 1991; Medin, 1989; Medin & Ortony, 1989). Medin (1989) described psychological essentialism as our tendency to "act as if things (e.g., objects) have essences or underlying natures that make them the thing that they are." (p1476). From the perspective of studying children's understanding of the cross-generational transmission of characteristics, it is interesting to note that a predisposition toward psychological essentialism implies that children could appropriately "match" offspring to parents without necessarily understanding anything about biological mechanisms underpinning this process. That is, they may be guided in their choices by some implicit, underlying awareness of shared "essence" (similar to what Hirschfeld, 1994, has called a "natural commonality" between parents and offspring.

METHOD

The series of four studies reported here involved 226 children between the ages of 3-11 years (specific breakdowns of subject data are listed below for each study). Children taking part in this research were presented with a number of different tasks, some involving people and some domestic animals. Each task had in common the requirement that children predict what kinds of physical and behavioral characteristics offspring would be most likely to demonstrate under different conditions of biological parentage and rearing environment. All tasks were made accessible to even the youngest children by using large colorful drawings of people and domestic animals, keeping the language of the interview as simple as possible, and providing pictures on cards to represent the potential offspring outcomes that children could select from.

In all studies children were asked to explain their choices and open ended commentary about the task and their own responses were encouraged. All sessions were videotaped and tapes were subsequently transcribed and coded for the explanation categories that children spontaneously used to tell us what they understood about family resemblances. Other data were also collected in

these studies, some of which has been or will be reported elsewhere, but the main focus of the present report is the children's own explanatory constructs.

Study 1. Young Preschoolers' Understanding of Family Resemblances

Subjects

A total of 20 children completed the study, 11 girls and 9 boys, ranging in age from 3 years 2 months to 4 years 11 months. Ten of the children were 3 year olds (M = 3 years, 6 months) and ten were 4 year olds (M = 4 years, 8 months).

Procedures

In this study the physical appearance and behavioral characteristics of human and animal mothers and fathers were manipulated, and children were asked to select the most likely offspring. Children were told that the offspring of the parents depicted on the cards were "still in mommy's tummy" (initial interview questions revealed that all children in the study understood this was where human and some animal babies grow) and their task was to decide what the offspring would look like/enjoy doing after it was born and had grown to be about the same age as them. Children were asked to subjectively rate ("Yes", "Maybe" or "No") the various physical and behavioral characteristics that the offspring might demonstrate. For example, given pictures of a dark skinned mother and a light skinned father, children were asked which for each of the four offspring whether it could be the one for this couple. There were always four selection choices with a parallel structure which, in this example, included a child with dark skin (like the mother), one with light skin (like the father), one with intermediate colored skin (a mix of both parents), and one with a ruddy complexion (unlike either of the parents). Other variables manipulated included hair texture, food likes / dislikes, and preferred activities for humans and parallel kinds of physical and behavioral characteristics for animals (e.g., hide color, tail length and texture, food likes / dislikes and preferred activities).

Study 2. Understanding Family Resemblances in KG - 2nd Grade

Subjects

A total of 66 children, with ages ranging from 5 years 5 months to 8 years 5 months completed the study; 22 each from kindergarten (8 girls, 14 boys), first grade (12 girls, 10 boys) and second grade (11 girls, 11 boys). The average ages of the children in the sample were 5 years 9 months at the kindergarten level, 7 years at first grade level, and 7 years 9 months at the second grade level.

Procedures

This task was presented using the same picture cards as for Study 1 and the procedures followed were very similar, with children being asked to assign a rating to the pictured options that represented what the offspring of each parent pair would look like / enjoy doing after it was born and had grown to be about the same age as the child interviewee. Children could place picture cards showing target options directly on the chart itself to indicate what rating they would assign for each option.

Study 3. Cross-Species Adoption and Expected Offspring Outcomes among KG -3rd Grade Children

Subjects

A total of 60 subjects, ranging in age from 4 years 10 months to 9 years 2 months, participated in the study. There were 15 in kindergarten (8 girls and 7 boys, M age = 5 years 4 months), 15 in first grade (8 girls and 7 boys, M age = 6 years 4 months), 15 in second grade (8 girls and 7 boys, M age =7 years 5 months) and 15 in third grade (7 girls and 8 boys, M age = 8 years 5 months)

Procedures

The procedures followed in this study were very similar to those previously described in which children were shown pictures, in this case of different domestic animals (e.g., pig, cow,

horse, sheep) and they were given a story about an adoption scenario where the offspring of one species was removed from its mother at birth and taken to a different farm where it was raised by animals of another species. Children were then asked to select the physical and behavioral characteristics that would be most likely for the adoptive offspring. Included among the selection options were physical and behavioral characteristics typical of either their biological species or their adoptive species, others that were a "mix" of both the biological and adoptive species, and others that were characteristic of neither of the presented species.

Study 4. The Effect of Cross-Species Inter-Uterine Transplants on KG- 5th Grade Children's Understanding of Biological Inheritance

Subjects

In all there were 80 subjects who completed this study, 15 each at KG through 3rd grade and 20 children in 5th grade. The children from the KG - 3rd grades consisted of 9 girls and 6 boys in kindergarten (M age = 5 years 6 months), 7 girls and 8 boys in first grade (M age = 6 years 5 months), 10 girls and 5 boys in second grade (M age =7 years 6 months) and 8 girls and 7 boys in third grade M age = 8 years 5 months). The 20 fifth grade children (9 boys, 11 girls) had an average age of 10 years 7 months.

Procedures

In this study an in-utero transplant condition was introduced where children were told a story about a pregnant animal who was very sick and so the baby inside her must be moved and placed inside another mother animal (of a different species) to finish growing until it can be born. Children saw the researcher physically move a card representation of a generic animal fetus from one animal to another and were quite accepting and unperturbed by this possibility. Children were then told that when the transplanted offspring were born they were raised either with the transplant species (Transplant-Raised Other condition) or went back to live with their original biological species (Transplant-Raised Own). As in the other studies, children were then asked to select the

physical and behavioral characteristics that the transplanted offspring would be most likely to express and the four options available were parallel to those used in the previous studies (i.e., like their original species, like the transplant species, a mix of their original and transplant species, and different from both the original and the transplant species.

RESULTS

Study 1

Children's explanations of their offspring selections and rejections were categorized by two independent raters from videotaped recordings of all test sessions. The criterion for interrater reliability was 95%, and disagreements were resolved by negotiation. All explanations were categorized into five main types, with an additional "Other" category for comments that could not be unambiguously classified, as shown in Table 1.

Figure 1 shows the proportions of explanation types by grade. It is immediately clear from this chart that for these very young children, the dominant explanation types are intentional (40% of all explanations for the 3 year olds and 31% for the 4 year olds) and essentialist (18% for the 3 year olds and 24% for the 4 year olds. The unclassifiable explanations were almost as frequent for this young group (37% and 24% for the 3 and 4 year olds, respectively) as were the intentional type, and this indicates just how much difficulty the children had in explaining why they made the particular selections they did. Explanations drawing on the child's own experience, beliefs about the influence of the rearing environment and biological mechanisms were infrequent among this young group (from 0 -12% maximum) but each of these types showed a marked increase from 3 to 4 years of age. The average frequency of explanations were analyzed using a 2 (age group) X 6 (explanation type) MANOVA with repeated measures on the second factor. There was a significant effect for explanations types, $F(5,90) = 6.535$, $p < 0.0001$, but no significant difference between the 3 and 4 year olds.

Study 2

Children's explanations were coded following the same procedures explained for Study 1 (see Table 1) and the percentage frequencies for each explanation type, by grade, are shown in Figure 2. For these children, explanations that drew directly and specifically on their own experience were the most common (32%, 38%, and 44% for the KG, 1st and 2nd grade children, respectively). Essentialist explanations were also used often by the children in this study (27%, 25%, and 31% for the youngest to oldest age groups, respectively). Biological explanations were offered for 20% of the responses by 2nd grade children, with lower rates, 17% and 11%, for the first grade and kindergarten children, respectively. Intentional explanations were much less common than in Study 1, occurring between 5-15% of the time among by the KG - 2nd graders. A 3 (grade) x 5 (explanation type, excluding the other category) MANOVA revealed significant differences among the explanation types, $F(4,252) = 6.852$, $p < .0001$, and for the explanations by grade interaction, $F(8,252) = 2.018$, $p < .045$).

Study 3

Children's explanations of their offspring selections and rejections were categorized by two independent raters from videotaped recordings of all test sessions to a 95% reliability criterion, with disagreements resolved through discussion. All explanations were coded into seven main types, with an additional "Other" category for comments that could not be unambiguously classified, and these are shown in Table 2.

The percentage frequency with which these explanation types occurred for each grade level are shown in Figure 3. A very strong essentialist effect is immediately apparent, with the children at all ages giving explanations that referred to species essence around 50% of the time. None of the other explanation types increased above 10-15%, and intentional explanations were occurring less than 10% of the time for the KG and 1st grade children and less than 5% of the time among

2nd and 3rd graders. A 4 (grade) x 7 (explanation type) MANOVA revealed a significant effect for explanation types, $F(6,336) = 15.707$, $p < .0001$, but no significant grade differences.

Study 4

The explanations offered by subjects in this study were coded in the same way as for Study 3 (see Table 2) and the percentage frequencies are shown in Figure 4. The transplant study offers a very mixed picture of what children understand about biological inheritance. There is a high proportion of basic essentialist explanations, varying between 12% for 5th graders and 44% for 2nd graders. However, other types of explanations, particularly those drawing on biological mechanisms, show an increased frequency in this study. It is noticeable that in this uterine transplant study, mention of the location of prenatal growth, or birth, as a specific biological mechanism explaining cross-generational transmission of species characteristics was higher than in any of the other studies (16%, 23%, 25%, 43%, and 31% for the KG, 1st, 2nd, 3rd and 5th grade children, respectively). The focus on inter-uterine transplant, and having children actually observe the "fetus" being moved from one mother to another obviously would make prenatal growth more salient for the children. However, it seems unlikely they would have offered this as an explanation unless the idea of prenatal growth as a causal mechanism was already present in their thinking. The most dramatic age difference can be seen among 5th grade children in the frequency of biological explanations that were not based on prenatal growth or birth (ranges from 2-10% among KG-3rd grade children and then jumps up to 36% for 5th graders. Many of these children mentioned "genes" and "DNA" as part of their rationale for offspring outcomes, although it was apparent that the children's understanding of these concepts was very limited. For example, some would say that the offspring might have features that were a mix of the original and transplant species because it would get DNA from both of the mothers.

GENERAL DISCUSSION

Overall, these findings reveal that among the youngest children (3-4 year olds) psychological intentional explanations dominate, and it is not until around 6-7 years of age (when children are typically in 1st-2nd grade) that explanations clearly begin to refer to physical processes and putative biological mechanisms. At this same age, there are is also frequent use of essentialist explanations. Between 4-6 years of age appears to be a transitional phase where performance and explanations are quite variable and seem to be somewhat task-dependent. When pressed to explain why families look alike, young children who have limited knowledge of specific biological mechanisms to draw on may fall back on intentional causality for want of an alternative. But when their attention is drawn to a salient physical process about which they do have some basic knowledge (i.e., uterine growth in the transplant study), then even kindergarten children are able to offer biologically based (even though incorrect) explanations for the cross-generational transmission of characteristics.

Around 6-7 years of age, the majority of children may have come to realize that family resemblances are the result of some autonomous force that is beyond human intentional control but how they come to this realization still remains to be explained. Clearly a substantial number of the 6-7 year old children in these and other studies have very limited knowledge about the specific biological mechanisms involved in the inheritance of familial characteristics. It may be that accurate knowledge of the specific biological mechanisms underpinning inheritance is unnecessary for a belief in biological causality to exist. This was evidenced in all of the studies involving non-human animals, but less so for humans, by the strong tendency for children of all ages to draw on essentialist explanations for their predictions. Biologically-based explanations for inheritance begin to take precedence around 10-11 years of age but the explanations given often reflected inaccurate understanding of genetic mechanisms. This is not surprising, since biological inheritance is a complicated process that many adults have difficulty explaining in accurate technical terms, yet this poor understanding does not prevent adults from referring to "genetic" causality.

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Table 1. Definitions and examples of explanation types given by children in Studies 1 and 2.

ESSENTIALIST "Because children usually look like their mom and dad"

"Because it's a girl puppy and they don't like to dig and get dirty"

Explanations that stated unequivocally that offspring would resemble their parents, without any explicit reference to biological mechanisms or rearing environment. Some of the responses in this category were stereotypical in nature, especially with reference to gender.

BIOLOGICAL MECHANISM "Because it grew inside it's mommy's tummy"

"Babies are made by a seed from their dad and an egg from their mom"

Explanations that refer specifically to some kind of biological mechanism for inheritance (even if incorrect) and this included references to prenatal uterine growth.

REARING ENVIRONMENT " If the mom reads to the baby then he will like reading too"

"Baby sheep follow the big sheep around and do the same things as them"

Responses that make reference to the environmental influences on offspring characteristics, whether behavioral or physical.

CHILD'S EXPERIENCE "Kids I know like listening to music better than reading"

"I think horses like apples best because that's what they get for a treat"

Responses that were not truly explanatory in the causal sense but did explain the child's reason for selection as an extrapolation from their own experiences.

INTENTION or DESIRE "The boy will have straight hair because his dad likes it best"

"The puppy will like swimming best because that's what I like too"

Explanations that referred to psychological justifications for outcomes, such as wants or desires, and sometimes included egocentric reference to the child's own preferences.

OTHER "I always pick the "Mix" one because it looks funny"

Any response that could not reasonably be included in the above categories, many of which were comments that were non-explanations.

Table 2. Definitions and examples of explanation types given by children in Studies 3 and 4.

SPECIES ESSENCE "It's a horse, that's what horses' tails look like"

Explanations that stated unequivocally that the offspringwas of a particular species, without any explicit reference to parentage or rearing environment.

ORIGINAL SPECIES "It started from a pig so it is going to have pig ears"

Statements that refer to the species from which the offspring originates, but without explicit reference to biological mechanisms or the location of prenatal growth.

PRENATAL PROXIMITY "It grew inside the horse mom so it will like to give rides"

Explanations that mention the fact of offspring being carried inside a particular species, or being physically born from a particular species.

BIOLOGICAL MECHANISM "It grew from sheep genes so it will look like a sheep"

Explanations that refer specifically to some kind of biological mechanism for inheritance (even if incorrect). Responses that referred only to prenatal uterine growth were excluded from this category and counted in the previous one.

FAMILY OF REARING "If it grows up with the pigs then it might learn to roll in the mud"

Responses that make reference to the environmental influences on offspring characteristics, whether behavioral or physical.

CHILD'S EXPERIENCE "Sometimes pigs give rides, I've seen that"

Responses that were not truly explanatory in the causal sense but did explain the child's reason for selection as an inference based on their own experiences.

INTENTION or DESIRE "It will be the mom's color because that will make her happy"

Explanations that referred to psychological justifications for outcomes, such as wants or desires, and sometimes included egocentric reference to the child's own preferences.

OTHER "I'm just guessing it will like to do that best"

Anything that could not reasonably be included in the above categories, many of which were comments that were non-explanations.

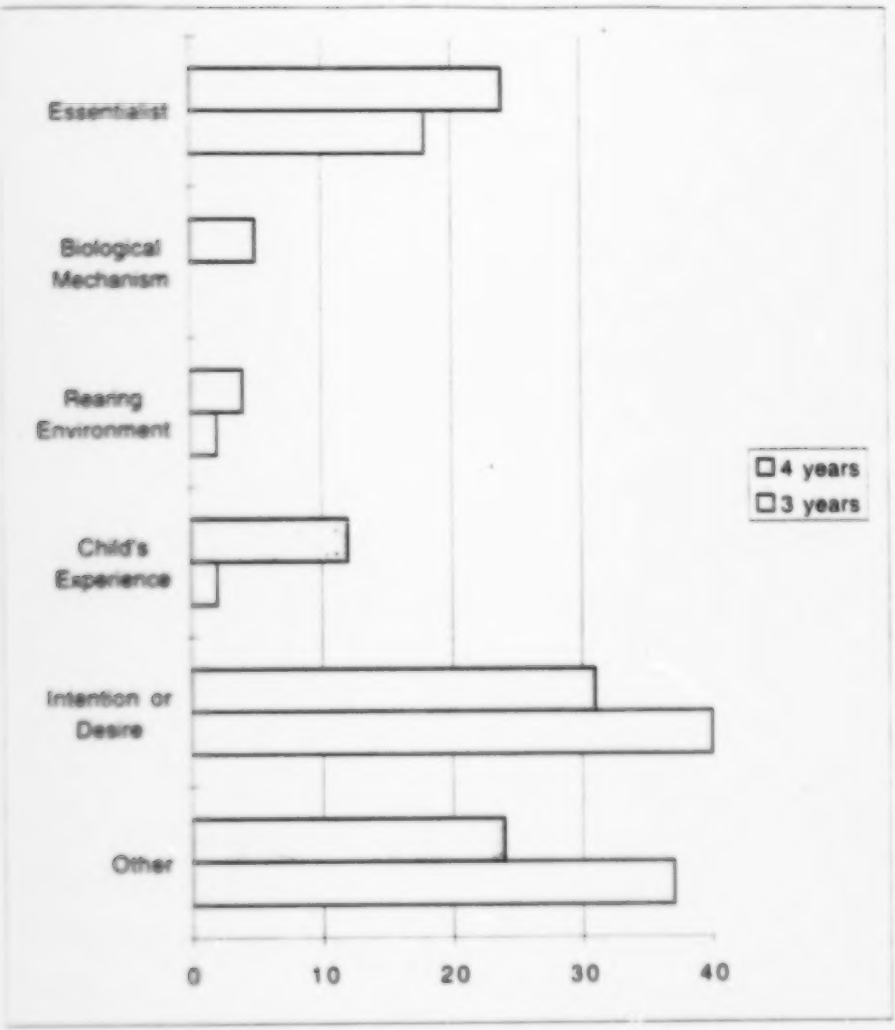

Figure 1. Percentage of each explanation type, by grade, that children gave for predicted offspring characteristics in Study 1.

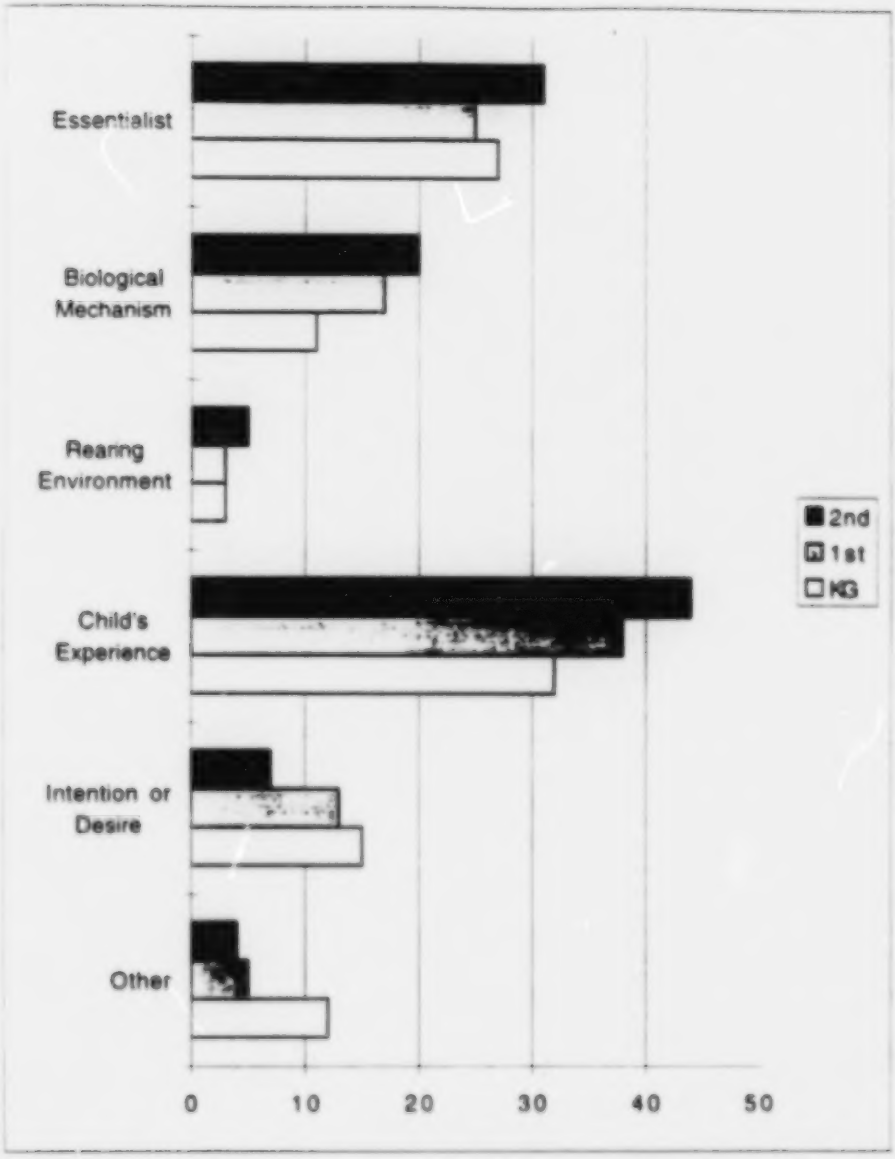

Figure 2. Percentage of each explanation type, by grade, that children gave for predicted offspring characteristics in Study 2.

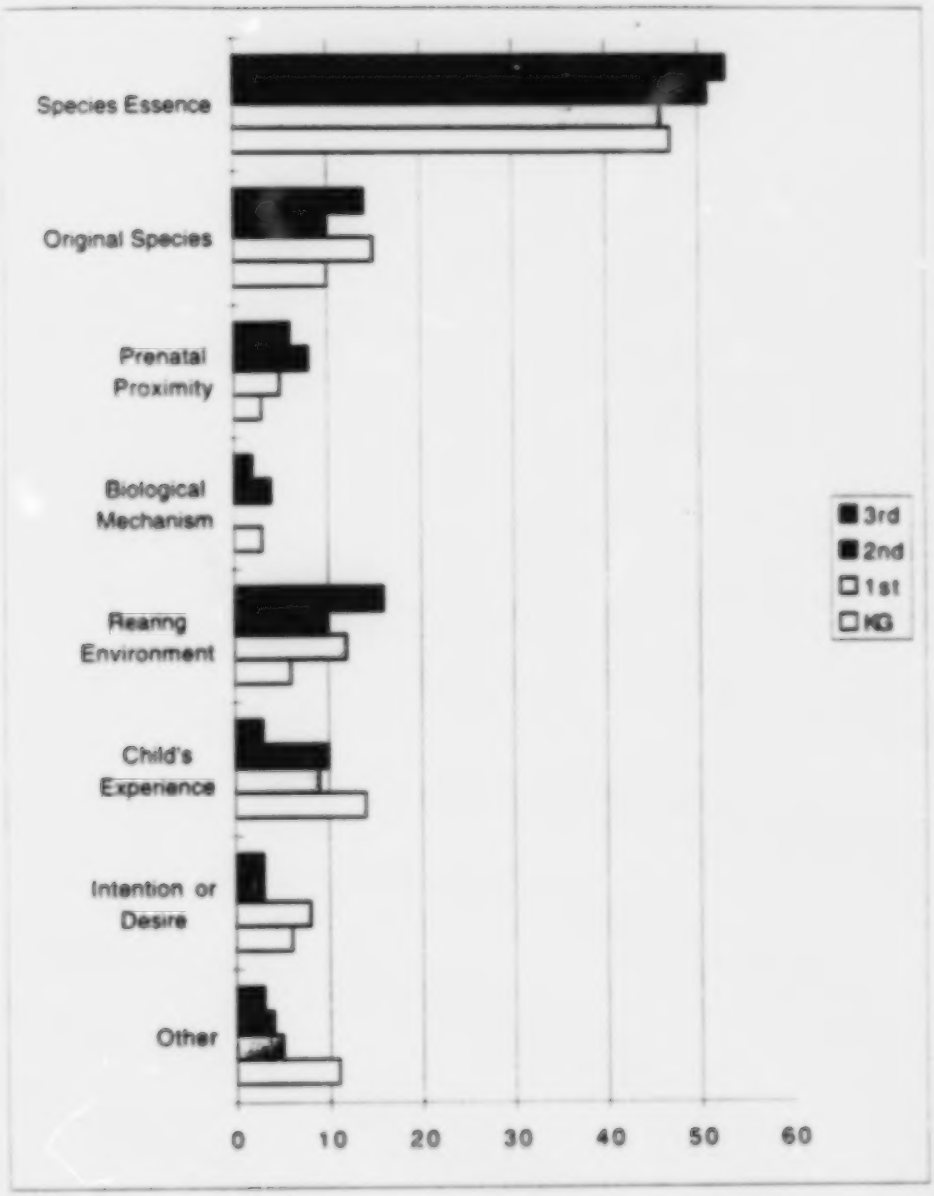

Figure 3.
Percentage of each explanation type, by grade, that children gave for predicted offspring characteristics in Study 3.

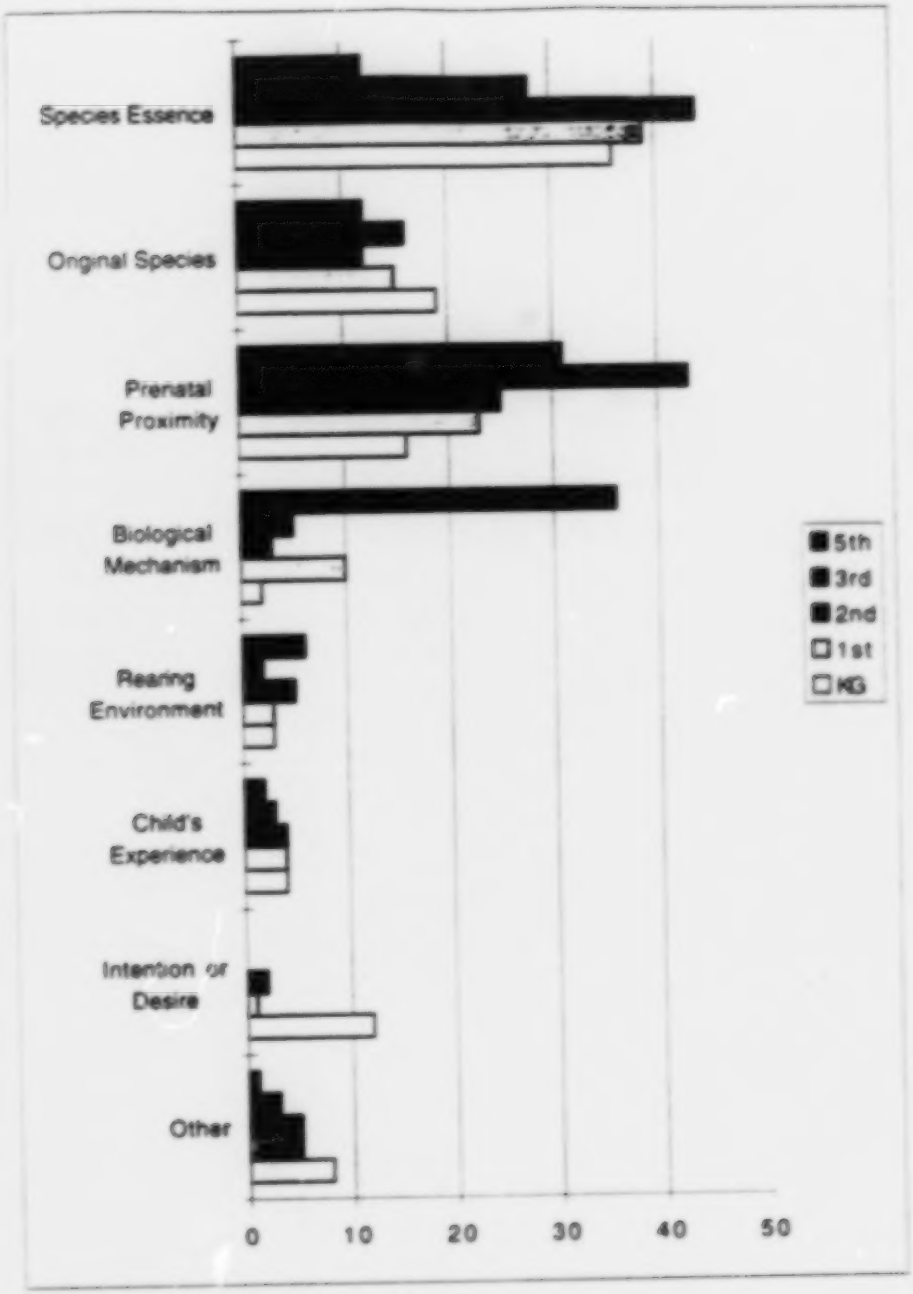

Figure 4. Percentage of each explanation type, by grade, that children gave for predicted offspring characteristics in Study 4.